Appendix C
MCR - Projection Calculations Based on 2002 Dredge Volumes (Contractor + USACE)

MODIFIED DREDGE IMPACT MODEL FOR ESTIMATING HOPPER DREDGE ENTRAINMENT IMPACTS TO COLUMBIA RIVER CRAB

Field Date	Field Location	Projection	Total Volume Dredged (cy)
2002	**Total MCR - Essayons+Contractor**	**2002 Total**	***4600378***

Sex Ratios by Age Class, Derived from July-Oct Data

Age Class	Total			Proportion		
	Male	Female	Sexed	Male	Female	
YOY	2	5	7	0.50	0.50	* binomial distribution p>0.05; low sample size - assumed to be 1:1.
1+	24	37	61	0.39	0.61	binomial distribution p=0.026; significantly different from 1:1
2+	25	113	138	0.18	0.82	binomial distribution p<0.001; significantly different from 1:1
3+	5	24	29	0.17	0.83	binomial distribution p<0.001; significantly different from 1:1

Estimates of Crab Entrainment Rate (R), Number of Crabs Entrained (E), Adult Equivalent Loss (AEL), and Variance (AEL)

Age Class	R	E	Var(E)	M	S to 2+	AEL at 2+	VAR(AEL 2+)	AEL at 3+	VAR(AEL 3+)
YOY	0.00335	15407.3		0.10	0.017	25.42		11.44	
1+	0.01440	66245.1		0.60	0.160	6359.53		2861.79	
2+	0.03218	148050.1		0.86	0.649	82632.68		37184.70	
3+	0.01040	47829.3		0.86	2.222	91397.89		41129.05	
All		**277531.7**				**180415.52**		**81186.98**	

Note: Entrained 3+ crab are back-calculated to provide AEL at 2+.

AGE 2+ Calculations

Contribution to Adult Equivalent Loss (AEL at 2+) and Variance (AEL at 2+) by Sex (MALE/FEMALE) and Age Class

Age Class	Female			Male		
	Proportion	AEL	VAR(AEL)	Proportion	AEL	VAR(AEL)
YOY	0.50	12.71		0.50	12.71	
1+	0.61	3857.42		0.39	2502.11	
2+	0.82	67662.99		0.18	14969.69	
3+	0.83	75639.64		0.17	15758.26	
All		**147172.75**			**33242.77**	

R = Crab Entrainment Rate (crabs/cy)
E = Crabs Entrained (number of Crabs)
M = Post-Entrainment Mortality (proportion)
S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%
AEL = Adult Equivalent Loss
VAR(AEL) =AEL Variance

Age Class Distribution

Age Class	% of Total	
	of Entrained	of AEL
YOY	5.55	0.00
1+	23.87	3.52
2+	53.35	45.80
3+	17.23	50.66

Age Class	Proportion of Total AEL	
	Male	Female
YOY	0.0001	0.0001
1+	0.0139	0.0214
2+	0.0830	0.3750
3+	0.0873	0.4193
ALL	0.18	0.82

AGE 3+ Calculations

Contribution to Adult Equivalent Loss (AEL at 3+) and Variance (AEL at 3+) by Sex (MALE/FEMALE) and Age Class

Age Class	Female			Male		
	Proportion	AEL	VAR(AEL)	Proportion	AEL	VAR(AEL)
YOY	0.50	5.72		0.50	5.72	
1+	0.61	1735.84		0.39	1125.95	
2+	0.82	30448.34		0.18	6736.36	
3+	0.83	34037.84		0.17	7091.22	
All		**66227.74**			**14959.24**	

R = Crab Entrainment Rate (crabs/cy)
E = Crabs Entrained (number of Crabs)
M = Post-Entrainment Mortality (proportion)
S = Natural Survivorship (proportion); survival to 3+ is assumed to be 45%
AEL = Adult Equivalent Loss
VAR(AEL) =AEL Variance

81186.984

Age Class Distribution

Age Class	% of Total	
	of Entrained	of AEL at 3+
YOY	5.55	0.01
1+	23.87	3.52
2+	53.35	45.80
3+	17.23	50.66

Age Class	Proportion of Total AEL at 3+	
	Male	Female
YOY	0.0001	0.0001
1+	0.0139	0.0214
2+	0.0830	0.3750
3+	0.0873	0.4193
ALL	0.18	0.82

SUMMARY VARIANCE DATA

Entrainment with Confidence Limits

E	277531.7
Var(E)	
SE E	
Z at 0.975	1.95996
95% C. I.	
CV E (%)	

TOTAL AEL at 2+ with Confidence Limits

AEL at 2+	180415.5
Var(AEL2+)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

TOTAL AEL at 3+ with Confidence Limits

AEL at 3+	81187.0
Var(AEL3+)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

SE = Standard Error
Z = Value of Z from Normal Distribution

C.I. = Confidence Interval
CV = Coefficient of Variation in %

MALE AEL at 3+ with Confidence Limits

AEL at 3+	14959.2
Var(AEL)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

FEMALE AEL at 3+ with Confidence Limits

AEL at 3+	66227.7
Var(AEL)	
SE AEL	
Z at 0.975	1.95996
95% C. I.	
CV AEL (%)	

TOTAL LOSS TO MALE FISHERY

(This total would be distributed over 3-4 years)

Male Age 3+ (number of crab)	Harvest Rate (proportion)	Lost to Fishery (number of crab)
14959.2	0.70	**10471.5**

Harvest rate of 0.70 is taken from Armstrong et al. (1987).

Loss to Fishery with Confidence Limits

Loss to Fishery	10471.5
Var(AEL)	
SE LF	
Z at 0.975	1.95996
95% C. I.	
CV LF (%)	

ADDITIONAL NOTES:

Mortality Rates (M) for crabs collected in June-September are from Armstrong et al. 1987 (Table 3.3, p. 61)
Survival rates (S) to age 2+ for crab collected from June-September are from Wainwright et al. 1992 (Table 6, p. 178), and thereafter survival rate from 2+ to age 3+ is 0.45 (Armstrong et al. 1987).
Sex ratios used were those observed or assumed to be 1:1 where sample size was low.